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FORM PTO-1390 (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: Kreisler 1090-KGB

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 09/600564

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE99/00175	15.Januar 1999 (15.01.99)	19.Januar 1998(19.01.98) DE 28.Juli 1998(28.07.98) DE

TITLE OF INVENTION
METHOD FOR IDENTIFYING T-CELL STIMULATING PROTEIN FRAGMENTS

APPLICANT(S) FOR DO/EO/US VOLK, Hans-Dieter; WALDEN, Peter; SCHEFFOLD, Alexander; BLASCZYK, Rainer

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [x] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [x] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [x] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [x] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [x] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [x] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [x] Other items or information:
    a. Copy of the English text
    b. Copy of an English translation of Sequence Listing
    c. Copy of International Preliminary Examination Report
    d. Copy of the published Application WO 99/36568

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U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/6U0264	PCT/DE99/00175	Kreisler 1090

	CALCULATIONS PTO USE ONLY	
17. [x] The following fees are submitted:		
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$970.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$840.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$760.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$670.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$96.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	13 - 20 =		X $18.00	$	
Independent claims	1 - 3 =		X $78.00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $260.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 840.00	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also by filed (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 840.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 840.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 840.00	
			Amount to be: refunded	$	
			charged	$ 840.00	

a. [ ] A check in the amount of $_____ to cover the above fees is enclosed.

b. [x] Please charge my Deposit Account No. 14-1263 in the amount of $ 840.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [x] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 14-1263. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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REGISTRATION NUMBER

Attorney Docket No. : Kreisler 1090-KGB

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	Hans-Dieter VOLK, et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	METHOD FOR IDENTIFYING T-CELL STIMULATING PROTEIN FRAGMENTS
Art Unit	:	To Be Assigned
Examiner	:	To Be Assigned

July 18, 2000

Hon. Assistant Commissioner
for Patents
Washington, D. C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE CLAIMS:

Cancel all the claims and substitute the following:

-- 14. A method for the identification of T-cell stimulating protein

fragments comprising the following steps:

a) establishing the amino acid sequence of an antigen which is a protein or a peptide;

b) subdividing the detected amino acid sequence of said antigen into protein fragments;

c) synthesizing at least one protein fragment having a length of from 8 to 30 amino acids, or cleaving the amino acid sequence of said antigen into at least one protein fragment having a length of from 8 to 30 amino acids, wherein said protein fragment is a subsequence of the established amino acid sequence of said antigen;

d) incubating a suspension containing T cells with the protein fragment or fragments in different experimental runs;

e) identifying of

(i) at least one T cell cytokin which has been induced by the protein fragment or fragments and synthesized in the T cells, wherein the T cell cytokin or cytokins remain within the cell or are bound to the cell membrane; and/or

(ii) at least one activation marker expressed or expression-enhanced due to the T cell stimulation by the protein

fragment or fragments which has been induced or expression-enhanced by the protein fragment or fragments and which is expressed in the T cells, wherein said activation marker can be present within the cell or expressed on the cellular surface;

wherein said T cell cytokin or cytokins or activation markers are identified by flow cytometry; and

f) assigning the experimental runs in which T cells have been stimulated and such stimulation has been recognized by the identification of one or more T cell cytokins and/or one or more activation markers, to the amino acid sequence or sequences of said protein fragments which had been incubated with the T cells;

characterized in that the incubation time is sufficiently long so that the protein fragment or fragments are sufficiently taken up by the MHC molecules present on the cellular surface, said taking up being sufficient when an unambiguous identification of stimulated T cells is possible; and the incubation time of the suspension containing T cells with the protein fragment or fragments is sufficiently short so that selection and proliferation accompanied by the specific elimination of particular T cells do not occur.

15. The method for the identification of T-cell stimulating protein fragments according to claim 14, wherein said identification of at least one T cell cytokin or activation marker is made on the individual cell level.

16. The method for the identification of T-cell stimulating protein fragments according to claim 14, wherein said suspensions containing T cells contain cells which present the protein fragment essentially in a state bound to MHC class I or class II molecules.

17. The method for the identification of T-cell stimulating protein fragments according to claim 14, wherein the protein fragment in the class I restricted presentation comprises from 9 to 11 amino acids, and the protein fragment in the class II restricted presentation comprises at least 11 amino acids.

18. The method for the identification of T-cell stimulating protein fragments according to claim 14, wherein said suspension containing T cells is a suspension of whole blood, peripheral white blood cells (PWBC), splenocytes, thymocytes, bone marrow, cerebrospinal fluid and/or lymph node cells.

19. The method for the identification of T-cell stimulating protein fragments according to claim 14, wherein said suspension containing T cells is derived from the patients to be subjected to therapy, from donors or from

animals.

20. The method for the identification of T-cell stimulating protein fragments according to claim 14, wherein the antigens, i.e., proteins or peptides, are derived from polycellular eukaryotes, cells, cell cultures and/or tissues of donors or patients.

21. The method for the identification of T-cell stimulating protein fragments according to claim 14, wherein the T cell cytokins are of the types interferon-γ, TNF-α or interleukin 2.

22. A process for the preparation of a protein fragment/peptide which is T-cell stimulating and whose amino acid sequence or initial amino acid sequence was found by the method for the identification of T-cell stimulating protein fragments according to claim 14, wherein said protein fragment/peptide is prepared by the solid phase method, liquid phase method or by protein biosynthesis in a host.

23. The process for the preparation of a protein fragment/peptide according to claim 22, wherein said protein fragment/peptide contains insertions, deletions or substitutions (modifications) wherein one, two, three or more amino acids have been exchanged, deleted or inserted, wherein said modified protein fragment/peptide has essentially the same function with

respect to the stimulation of T cells as the non-modified protein fragment/peptide.

24. The process for the preparation of a protein fragment/peptide according to claim 22, wherein said protein fragment/peptide contains at least one additional naturally occurring or not naturally occurring amino acid and/or a protecting group at the N-terminal and/or C-terminal end (extended modification), wherein the extendedly modified protein fragment/peptide has essentially the same function with respect to the stimulation of T cells as the non-modified protein fragment/ peptide.

25. Method of using a protein fragment/peptide prepared by the process according to claim 22 for the preparation of a medicament for immune stimulation.

26. The method of a protein fragment/peptide according to claim 25, wherein said immune stimulation is a vaccination or desensitization. - -

REMARKS

The foregoing amendments conform the claims to conventional U.S. format, and eliminate multiple dependencies.

Early and favorable action is earnestly solicited.

Respectfully submitted,
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APPENDIX

Attorney Docket No. : Kreisler 1090 KGB

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"Express Mail" Mailing Label No. EH976287997US
I hereby certify that this paper or fee is being deposited with the United States Postal Services "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated below and is addressed to the: The Assistant Commissioner for Patents, Washington, DC 20231, on 7/18/00

NORRIS McLAUGHLIN & MARCUS, P.A.

By [signature]

SMB

A Method for Identifying T-Cell Stimulating Protein Fragments

The present invention relates to a method for the identification of T-cell stimulating protein fragments by means of T cell induction, a process for the preparation of protein fragments having a sequence which was found by the method according to the invention, and the use of such protein fragments for immune stimulation.

Prior art

The T-cell stimulating protein fragments comprise T cell epitopes which are specifically recognized by T cell receptors and through this recognition stimulate the T cell biosynthesis, inter alia, of cytokines secreted in the usual way.

A known method for the identification of T-cell stimulating protein fragments consists in subdividing a protein the amino sequence of which is known into individual overlapping protein fragments. The corresponding synthetically prepared protein fragments are incubated with T cells singly or in groups. After one to three weeks, cell lines or cell clones may be present which could be specifically stimulated by the protein fragment or by at least one of the protein fragments employed. The specificity of these lines or clones can be detected by cytotoxicity tests with appropriate target cells. Due to the experimental design, the stimulated cell lines or cell clones can be assigned to the corresponding T-cell stimulating protein fragments. This method is described in detail in P. Walden et al. (1996), Current Opinion in

Immunology, Vol. 8, pp 68-74. Alternatively, the proliferation of cells can be determined after 1 week by the incorporation of ^{3}H-thymidine, which method is subject to higher non-specificity, however.

A drawback of these two methods is the high expenditure in terms of apparatus, personnel and time. In addition, it is probable that stimulated T cells die during the long incubation time, e.g., by activation-induced programmed cell death (apoptosis), from which false negative results are obtained.

A method for the flow-cytometric identification of antigen-specific T cells according to S.L. Waldrop et al. (1997), Determination of Antigen-Specific Memory/Effector CD4+ T Cell Frequencies by Flow Cytometry: Evidence for a Novel Antigen-Specific Homeostatic Mechanism in HIV-Associated Immunodeficiency, J. Clin. Invest., Vol. 99, pp 1739-1750, consists in incubating proteins as antigens with peripheral blood mononuclear cells (PBMC). These proteins are processed and presented by antigen-presenting cells. This processing results in protein fragments with which MHC class II molecules are loaded and then arrive at the cellular surface (antigen presentation). The T cells respectively stimulated by the recognition of protein fragments are identified by flow cytometry. It is neither possible to establish the stimulating protein fragments, nor to assign the specifically induced T cells to the inducing protein fragments. The object of this experimental design is mainly to establish whether epitopes presented by MHC class II molecules are present in a protein or a complex antigen, or whether an individual possesses specific MHC class II restricted T cells against such epitopes which may be present or are known to be present, and how high the frequency of these cells is (quantification of the antigen-specific T cells). In addition, further properties of the stimulated T cells can be established (surface markers etc.). However, neither the amino acid

sequence of existing epitopes nor the frequency of such epitopes can be established.

Problem and solution

Therefore, it has been the object of the invention to provide a method by which protein fragments the amino acid sequences of which are known can be identified as stimulating protein fragments within a short period of time. The method is to work also for a small number of T cells without T cell lines or cell clones having to be available. Further, among a large number of protein fragments, it should be possible to detect those which stimulate T cells.

This object is achieved by a method for the identification of T-cell stimulating protein fragments comprising the following steps:

a) establishing the amino acid sequence of an antigen which is a protein or a peptide;

b) subdividing the detected amino acid sequence of said antigen into protein fragments;

c) synthesizing at least one protein fragment having a length of from 8 to 30 amino acids, or cleaving the amino acid sequence of said antigen into at least one protein fragment having a length of from 8 to 30 amino acids, wherein said protein fragment is a subsequence of the established amino acid sequence of said antigen;

d) incubating a suspension containing T cells with the protein fragment or fragments in different experimental runs;

e) identifying of

(i) at least one T cell cytokin which has been induced by the protein fragment or fragments and synthesized in the T cells, wherein the T cell cytokin or cytokins remain within the cell or are bound to the cell membrane; and/or

(ii) at least one activation marker which has been induced or expression-enhanced by the protein fragment or fragments and which is expressed in the T cells, wherein said activation marker can be present within the cell or expressed on the cellular surface;

wherein said T cell cytokin or cytokins or activation markers are identified by flow cytometry; and

f) assigning the experimental runs in which T cells have been stimulated and such stimulation has been recognized by the identification of one or more T cell cytokins and/or one or more activation markers, to the amino acid sequence or sequences of said protein fragments which had been incubated with the T cells.

Advantages

The main advantage of this method according to the invention is that a protein segment with a known sequence can be identified as a T-cell stimulating protein fragment within a very short period of time and, as compared with the conventional method, with very little expenditure. The time between the first incubation of T cells and the flow-cytometric evaluation can be six hours. Extremely low numbers of cells may be sufficient. If a number of 1×10^6 peripheral white blood cells are initially used, a positive response can be unambiguously established even when 0.1% of the initial number of T cells are stimulated T cells. In contrast, the classical method requires a number of cells of about 8×10^6 peripheral

white blood cells per protein fragment or mixture of protein fragments to be able to perform a successful cytotoxicity test subsequently. Thus, the method according to the invention can be employed with high efficiency for the T cell epitope mapping of protein antigens.

Further, mixtures of freshly isolated cellular blood cells or tissue cells can be used. T cell lines or cell clones are not necessary for this method according to the invention. This results in advantages in terms of less time required for incubation and further, very essentially, in terms of the viability of the T cells which are present as a large pool with a high variability within the short incubation time. Selection and proliferation accompanied by the specific elimination of particular T cells do not occur in the method according to the invention due to the short incubation times.

Preferred sources of the T cells to be stimulated are donors who have previously built up an immunological primary response to the antigen. This may have happened, for example, during an infection or during an immunization. The same situation is found in an autoimmune response.

Another advantage is that the MHC type of the donor need not be known. Thus, for example, protein fragments with 9 amino acids from one protein are incubated with the T cells without knowing the MHC type of the blood or cell donor. Nevertheless, the T-cell stimulating protein fragments can be identified. Thus, knowing the MHC type is not necessary for identifying the epitope. In classical tests using cytotoxic T cell lines or T cell clones, the MHC type of the target cell lines must match that of the effector cells. Establishing target cell lines from donor blood represents an additional expenditure in terms of material and time.

Further, a large number of protein fragments can be incubated at the same time by the method according to the invention. Low cell numbers and the

highly sensitive detection of stimulated T cells allow the identification of the T-cell stimulating protein fragments with clear advantages in time.

Since the number of the protein fragments to be examined can be very high due to the fact that little work is necessary, it is not necessary to narrow down possible epitopes by theoretical predictions. The epitopes are found in a purely empirical way, and therefore, even those T cell epitopes can be found which would not be derived from a theoretical prediction.

With this method, T cells which can be specifically stimulated by particular selected protein fragments can be easily identified.

On the one hand, T-cell stimulating protein fragments bind to defined MHC molecules, and on the other hand, they contain amino acid sequences (epitopes) which can undergo binding to the antigen binding region of the T cell receptor (paratope).

An essential feature of the terms protein or peptide is a sequence of at least nine amino acids. It is not important how the sequence was established. Thus, for a new protein, the sequence may be analyzed for the first time, or for a known protein, it may be read from a data base. The only important thing is that the amino acid sequence of the protein fragment has been determined. The subdivision of the protein or peptide sequence may also be made in a number of different ways. Thus, the protein fragments can be derived from one protein stepwise by the variation of one amino acid. Other overlapping schemes are also possible. This is the classical method of protein mapping.

Suspensions containing T cells within the meaning of this application are characterized by containing cells which are capable of presenting MHC-bound peptides. Thus, in addition to the antigen-presenting cells, the presenting cells may also be T cells, for example.

Further embodiments

The method according to the invention is advantageous in the identification of T-cell stimulating protein fragments since said identification of at least one T cell cytokin or activation marker is made on an individual cell level. Even extremely small amounts of T cells containing intracellular cytokins or cytokins bound to the cell membrane are sufficient.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is preferred that said suspensions containing T cells contain cells which present the protein fragment essentially with MHC class I or II molecules (MHC = major histocompatibility complex). In addition to the amino acids serving for anchoring in the cleft of the MHC molecule (binding anchor), particular sequences which are specifically recognized by a T cell receptor (T cell epitopes) must be present for the protein fragment to function as a T cell epitope.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is preferred that the protein fragment in the class I restricted presentation comprises from 9 to 11 amino acids and the protein fragment in the class II restricted presentation comprises at least 11 amino acids. It is known that protein fragments binding to MHC class I molecules (MHC = major histocompatibility complex) usually have a length of 9 amino acids whereas protein fragments binding to MHC class II molecules are somewhat longer and more variable in length.

It is advantageous that the protein fragments, despite the short incubation time, are sufficiently taken up by the MHC molecules present on the cellular surface to enable an unambiguous identification of stimulated T cells after six hours, for example. Further, if short protein fragments are used (class I with 9 amino acids and class II with preferably 11-15 amino acids), the

epitope present in a stimulating amino acid sequence can be narrowed down to a maximum extent.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is preferred that said suspension containing T cells is a suspension of whole blood, peripheral white blood cells (PWBC), splenocytes, thymocytes, bone marrow, cerebrospinal fluid and/or lymph node cells. The method is considerably simplified by the fact that the suspensions containing T cells may be derived from a wide variety of sources. Further, it is particularly advantageous that processing of the T cells is not required. Thus, the T cells need not be enriched, and removal or destruction of other cells is not necessary. In this way, the method according to the invention can be handled more simply as a routine method. The method is less susceptible to interference from culture conditions, contaminations, selections due to culturing and the selecting of specific clones, as compared to the conventional method. A representative picture of T cells in general and T cells stimulated by protein fragments can be established by this method.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is preferred that said suspension containing T cells is derived from the patients to be subjected to therapy, from donors or from animals. If the suspension containing T cells is derived from a patient, the identification may be used, for example, to establish against which protein fragment/epitope of a viral antigen a T cell response can be induced. Such a protein fragment/epitope can then be selectively employed for the stimulation of additional T cells in the patient. The thus induced and proliferation-stimulated cells can thus be expanded and subsequently reinfused into the patient.

The method according to the invention can also be used in veterinary medicine. A wide variety of animal species and also constellations of animal patients and donors as a source of the suspension containing T cells can be contemplated.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is preferred that the antigens, i.e., proteins or peptides, are derived from microorganisms, macroorganisms, cells, cell cultures and/or tissues of donors or patients. Microorganisms include, for example, viruses, bacteria, fungi, monocellular organisms, parasites. Macroorganisms include, for example, all polycellular eukaryotes. This is the very source which is important to influencing allergies. This includes animals and plants. Cells, cell cultures or even whole tissues consisting of one or more strata or cell types can be used.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is preferred that the T cell cytokins are of the types interferon-γ, TNF-α (tumor necrosis factor-alpha) or interleukin 2. However, other cytokins are also possible. The only precondition is that these cytokins can be fluorescence-labeled.

Activation markers which are expressed or expression-enhanced due to the T cell stimulation by the protein fragments can also be identified. This may be exemplified by the marker CD69. For the identification of activation markers which are present on the cellular surface or which are not secreted, inhibition of secretion may no longer be required.

Cytokins and surface markers are described in detail in Abul K. Abbas et al. (1997), Cellular and Molecular Immunology, Philadelphia, 3rd edition, ISBN 0-7216-4024-9.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is more preferred that the T cell cytokins remain within the cell after inhibition of secretion. It is important that the stimulation observed can be unambiguously assigned to T cells.

In the method according to the invention for the identification of T-cell stimulating protein fragments, it is preferred that the stimulation is detected by flow cytometry. The essential principle is that markers present within the cell or on its surface, such as cytokins or surface markers, are contacted with a specific detector, for example, an antibody, the detector being loaded with a fluorescent dye. After excitation by laser light of this fluorescent dye on the cells focused in a liquid flow, the flow cytometer records the emitted scattered light and fluorescence signals so that a simultaneous or later analysis of the cells is possible. Such techniques are described in detail in Howard M. Shapiro (1995), Practical Flow Cytometry, New York, 3rd edition, ISBN 0-471-30376-3. The detection of intracellular cytokins is described in L.J. Picker et al. (1995), Blood, Vol. 86, pp 1408.

Preparation of T-cell stimulating protein fragments

The invention further comprises a process for the preparation of a protein fragment/peptide which is T-cell stimulating and whose amino acid sequence or initial amino acid sequence was found by the method according to the invention for the identification of T-cell stimulating protein fragments, wherein said protein fragment/peptide is prepared by the solid phase method, liquid phase method or by protein biosynthesis in a host.

Solid phase synthesis: Solid phase synthesis is described in detail in Solid Phase Synthesis, E. Atherton and R.C. Sheppard (1989), IRL Press, ISBN 1-85221-133-4, and Amino Acid and Peptide Syntheses, J. Jones, Oxford Science Publication (1992), ISBN 0-19-855668-3.

Liquid phase synthesis: The liquid phase synthesis or solution technique is set forth in Methoden der Organischen Chemie (Houben/Weyl), Vol. 15/Nos. 1 and 2, E. Wünsch (editor), Thieme Verlag Stuttgart, 1974.

In a process for the preparation of a protein fragment/peptide which is T-cell stimulating and whose amino acid sequence or initial amino acid sequence was found by the method according to the invention for the identification of T-cell stimulating protein fragments, wherein said protein fragment/peptide is prepared by the solid phase method, liquid phase method or by protein biosynthesis in a host, it is further advantageous when said protein fragment/peptide contains insertions, deletions or substitutions (modifications) wherein one, two, three or more amino acids have been exchanged, deleted or inserted, wherein said modified protein fragment/peptide has essentially the same function with respect to the stimulation of T cells as the non-modified protein fragment/peptide.

In a process for the preparation of a protein fragment/peptide of the kind as mentioned above, it is particularly advantageous when said protein fragment/peptide contains at least one additional naturally occurring or not naturally occurring amino acid and/or a protecting group at the N-terminal and/or C-terminal end (extended modification), wherein the extendedly modified protein fragment/peptide has essentially the same function with respect to the stimulation of T cells as the non-modified protein fragment/peptide.

Abbreviations: The abbreviations used in the text are defined by the rules established by the IUPAC-IUB Commission for Biochemical Nomenclature (Biochemistry 11: 1726 (1972), and Biochem. J. 219: 345 (1984)). The following usual abbreviations are employed: Ala = A = alanine; Arg = R = arginine; Asn = N = asparagine; Cys = C = cysteine; Gln = Q = glutamine; Glu = E = glutamic acid; Gly = G = glycine; His = H = histidine; Ile = I =

isoleucine; Leu = L = leucine; Lys = K = lysine; Met = M = methionine; Phe = F = phenylalanine; Pro = P = proline; Ser = S = serine; Thr = T = threonine; Trp = W = tryptophan; Tyr = Y = tyrosine; and Val = V = valine.

It is advantageous if the protein fragments presented in a state bound to MHC class II molecules have amino protecting groups or carboxy protecting groups or their variants, depending on the type of terminus.

The protecting group or its variants for the N terminus can be alkyl, aryl, alkylaryl, aralkyl, alkylcarbonyl or arylcarbonyl groups having from 1 to 10 carbon atoms, preferably naphthoyl, naphthylacetyl, naphthylpropionyl, benzoyl groups, or an acyl group having from 1 to 7 carbon atoms.

The protecting group or its variants for the C terminus can be an alkoxy or aryloxy group having from 1 to 10 carbon atoms, or an amino group.

Use of T-cell stimulating protein fragments as a medicament

Particularly preferred is the use of a protein fragment/peptide whose amino acid sequence or initial amino acid sequence was found by the method according to the invention for the identification of T-cell stimulating protein fragments and which was produced by the preparation process according to the invention, for the preparation of a medicament for immune stimulation.

In said use of a protein fragment/peptide, it is more preferred that said immune stimulation is a vaccination or desensitization.

In said vaccination, the sequence of proteins from viruses, bacteria, monocellular or polycellular eukaryotes as antigens is established and then subdivided into protein fragments which are added to suspensions containing T cells according to the invention. The positive samples in which

a T-cell stimulating protein fragment is present are used as a starting point for the preparation of a vaccine.

In said desensitization, protein fragments/peptides are established which trigger the undesired immunological response. Then, the T-cell stimulating protein fragments/peptides or the medicaments prepared therefrom according to the preparation method are administered to the patient. The respectively desired effect (stimulation or desensitization) is achieved or enhanced through the kind and site of the application and the dosage (e.g., high-dose or low-dose tolerance induction) and the accompanying administration of, for example, stimulating or tolerifying cytokins or similar medicaments having immunomodulatory activity. Protein fragments which were not found by this method according to the invention have already been successfully employed as medicaments, e.g., in the vaccination of bovines against foot-and-mouth disease (Collen et al., J. Immunol. 1991; 146: 749-755). The peptide identified in our Example was independently found by another group using conventional technology and is being tested as a vaccine (Diamond et al., Blood 1997; 5: 1751-1767).

Examples

Example 1

(see Figure 1/2)

Mononuclear cells were prepared from the peripheral blood, obtained by venous punction, of an HLA-typed female patient possessing the MHC class I allele HLA-A*0201. The patient additionally possessed antibodies against human cytomegalovirus. The cells prepared by a standard method were incubated with the peptides stated below for six hours under optimized conditions. These peptides are fragments of a protein fragment, known from the literature, of the pp65 protein of human cytomegalovirus (Swiss-

Prot PO6725) having a length of 15 amino acids (Ala Arg Asn Leu Val Pro Met Val Ala Thr Val Gln Gly Gln Asn, $pp65_{493-507}$). This protein fragment is known to be capable of inducing HLA-A2 restricted cytotoxic T cells in a bulk culture, i.e., to contain a T-cell epitope presented with HLA-A2 (M.R. Wills et al. (1996), J. Virol. Vol. 70, pp 7569-5779). The length of 9 amino acids for the fragments to be tested was chosen because this is the typical length of epitopes presented with MHC class I molecules (H.G. Rammensee et al. (1995), Immunogenetics, Vol. 41, pp 178-228). The peptides used respectively overlap by 8 amino acids, for successive peptides, and thus comprise all possible fragments of this length. The peptides were employed as a mixture of all peptides or singly. The peptide concentration in the Example shown was 1 µg/ml for each peptide.

The following peptides were employed:

1) Ala Arg Asn Leu Val Pro Met Val Ala
2) Arg Asn Leu Val Pro Met Val Ala Thr
3) Asn Leu Val Pro Met Val Ala Thr Val
4) Leu Val Pro Met Val Ala Thr Val Gln
5) Val Pro Met Val Ala Thr Val Gln Gly
6) Pro Met Val Ala Thr Val Gln Gly Gln
7) Met Val Ala Thr Val Gln Gly Gln Asn

Incubations with the mixture of all peptides (Figure: upper left diagram) and with peptide 3 alone (Figure: middle column, second diagram from above) resulted in the production of IFN-γ in T cells, detected by measurement in a flow cytometer on the individual cell level (J.L. Picker et al. (1995), Blood, Vol. 86, pp 1408-1419). None of the other individually tested peptides had this effect. A study published in the literature identified exactly the same epitope within the same protein segment by conventional

methods and clearly confirms our result (D.J. Diamond et al. (1997), Blood, Vol. 90, pp 1751-1767).

Legend for Figure 1/2:

Detection of intracellular interferon-γ in $CD8^+$ T lymphocytes after stimulation with a mixture of the 7 peptides stated (upper row, leftmost diagram) or the individual peptides, $pp65_{493-501}$ to $pp65_{499-507}$. The marker CD69 was used as an activation marker. The representation is limited to $CD3^+/CD8^+$ events, and the average fluorescence intensity is stated.

Example 2

(see Figure 2)

Mononuclear cells were prepared from the peripheral blood, obtained by venous punction, of an HLA-typed female patient possessing the MHC class II allele HLA-DR11. The patient additionally possessed antibodies against human cytomegalovirus. The cells prepared by a standard method were incubated with mixtures of 11 or 12 peptides each having a length of 15 amino acids with 11 overlaps respectively, corresponding to the sequence of the pp65 matrix phosphoprotein (Swiss-Prot PO6725), for six hours under optimized conditions (a total of 138 peptides). The peptide concentration was 1 µg/ml for each peptide. Three out of a total of 24 mixtures clearly stimulated $CD4^+$ T cells. Due to the experimental design (occurrence of particular peptides in particular mixtures), 2 peptides could thus be clearly identified which were responsible for the stimulation. This result was confirmed by the stimulation with the respective individual peptides under otherwise equal conditions. The identified peptides were the neighboring peptides $pp65_{365-379}$ and $pp65_{369-383}$. These sequences are largely congruent with the following HLA-DR11-presented peptide sequences described in the literature, which were identified as T-cell

stimulating sequences in the conventional way: $pp65_{361-376}$ and $pp65_{369-384}$ (Khattab et al. (1998), Journal of Medical Virology, Vol. 52, pp 68-76), i.e., the stimulating peptides are found within the segment defined by the amino acids 361 and 384. A further narrowing down of the epitope sequence to the postulated length of 11 amino acids has not been done.

Legend for Figure 2/2:

Detection of intracellular interferon-γ in $CD3^+/CD8^-$ T lymphocytes (left) after stimulation with the peptide mixtures 8, 9 and 20, or in $CD3^+/CD4^+$ T lymphocytes (right) after stimulation with the individual peptides $pp65_{365-379}$ and $pp65_{369-383}$. In the screening (right), peptide mixtures were used, and CD3 and CD8 were used as T cell markers. Since the INF-γ^+ populations on the left side are $CD3^+/CD8^-$, the marker CD4 was used for retesting. The stimulated T cells are clearly $CD4^+$. Only $CD3^+$ cells are shown, and the average fluorescence intensity is stated.

PCT WELTORGANISATION FÜR GEISTIGES EIGENTUM
Internationales Büro

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Veröffentlicht

Ohne internationalen Recherchenbericht und erneut zu veröffentlichen nach Erhalt des Berichts.

(54) **Title:** METHOD FOR IDENTIFYING T–CELL STIMULATING PROTEIN FRAGMENTS

(54) **Bezeichnung:** VERFAHREN ZUM IDENTIFIZIEREN VON T–ZELL–STIMULIERENDEN PROTEINFRAGMENTEN

(57) **Abstract**

The invention relates to a method for identifying T–cell stimulating protein fragments using the following steps: a) detecting the amino acid sequence of an antigen; b) subdividing the found amino acid sequence of the antigen into protein fragments; c) synthesizing at least one protein fragment; d) incubating a suspension containing t–cells with the protein fragments; e) identifying an induced T–cell cytokine or activation marker by flow–through cytometry, and; f) assigning the T–cells, with which T–cell cytokines and/or activation markers were identified, to the protein fragments which were incubated with the T–cells. The corresponding protein fragments/peptides are synthetically produced with the assistance of the detected positive sequence, and said corresponding protein fragments/peptides can be utilized to produce a medicament for immunostimulation.

(57) **Zusammenfassung**

Die Erfindung betrifft ein Verfahren zum Identifizieren von T–Zell–stimulierenden Proteinfragmenten mit den folgenden Schritten: a) Ermitteln der Aminosäuresequenz eines Antigens, b) Unterteilen der gefundenen Aminosäuresequenz des Antigens in Proteinfragmente, c) Synthetisieren von mindestens einem Proteinfragment, d) Inkubieren einer T–Zellen enthaltenden Suspension mit den Proteinfragmenten, e) Identifizieren von einem induzierten T–Zell–Zytokin oder Aktivierungsmarker, durch Durchflusszytometrie, und f) Zuordnen der T–Zellen, bei denen T–Zell–Zytokine und/oder Aktivierungsmarker identifiziert wurden, zu den Proteinfragmenten, welche mit den T–Zellen inkubiert wurden. Mit Hilfe der ermittelten positiven Sequenz werden die entsprechenden Proteinfragmente/Peptide synthetisch hergestellt und lassen sich zur Herstellung eines Medikamentes zur Immunstimulation verwenden.

CLAIMS:

1. A method for the identification of T-cell stimulating protein fragments comprising the following steps:

a) establishing the amino acid sequence of an antigen which is a protein or a peptide;

b) subdividing the detected amino acid sequence of said antigen into protein fragments;

c) synthesizing at least one protein fragment having a length of from 8 to 30 amino acids, or cleaving the amino acid sequence of said antigen into at least one protein fragment having a length of from 8 to 30 amino acids, wherein said protein fragment is a subsequence of the established amino acid sequence of said antigen;

d) incubating a suspension containing T cells with the protein fragment or fragments in different experimental runs;

e) identifying of

(i) at least one T cell cytokin which has been induced by the protein fragment or fragments and synthesized in the T cells, wherein the T cell cytokin or cytokins remain within the cell or are bound to the cell membrane; and/or

(ii) at least one activation marker which has been induced or expression-enhanced by the protein fragment or

fragments and which is expressed in the T cells, wherein said activation marker can be present within the cell or expressed on the cellular surface;

wherein said T cell cytokin or cytokins or activation markers are identified by flow cytometry; and

f) assigning the experimental runs in which T cells have been stimulated and such stimulation has been recognized by the identification of one or more T cell cytokins and/or one or more activation markers, to the amino acid sequence or sequences of said protein fragments which had been incubated with the T cells.

2. The method for the identification of T-cell stimulating protein fragments according to claim 1, wherein said identification of at least one T cell cytokin or activation marker is made on the individual cell level.

3. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein said suspensions containing T cells contain cells which present the protein fragment essentially in a state bound to MHC class I or class II molecules.

4. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein the protein fragment in the class I restricted presentation comprises from 9 to 11 amino acids, and the protein fragment in the class II restricted presentation comprises at least 11 amino acids.

5. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein said suspension containing T cells is a suspension of whole blood, peripheral white blood cells (PWBC), splenocytes, thymocytes, bone marrow, cerebrospinal fluid and/or lymph node cells.

6. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein said suspension containing T cells is derived from the patients to be subjected to therapy, from donors or from animals.

7. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein the antigens, i.e., proteins or peptides, are derived from macroorganisms, cells, cell cultures and/or tissues of donors or patients.

8. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein the T cell cytokins are of the types interferon-γ, TNF-α or interleukin 2.

9. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein the T cell cytokins remain within the cell after inhibition of secretion.

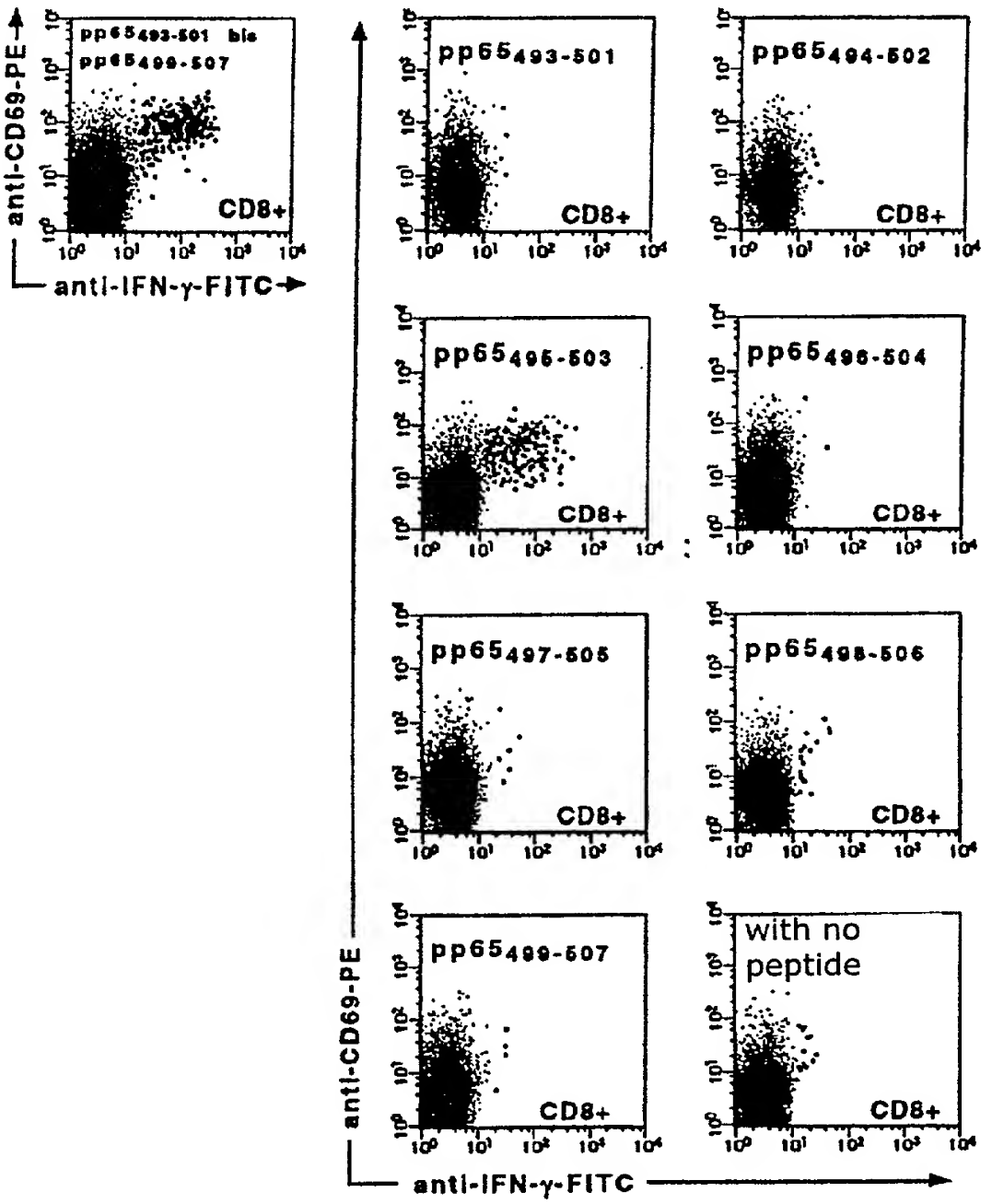
10. A process for the preparation of a protein fragment/peptide which is T-cell stimulating and whose amino acid sequence or initial amino acid sequence was found by the method for the identification of T-cell stimulating protein fragments according to any of the preceding claims 1 to 9, wherein said protein fragment/peptide is prepared by the solid phase method, liquid phase method or by protein biosynthesis in a host.

11. The process for the preparation of a protein fragment/peptide according to claim 10, wherein said protein fragment/peptide contains insertions, deletions or substitutions (modifications) wherein one, two, three or more amino acids have been exchanged, deleted or inserted, wherein said modified protein fragment/peptide has essentially the same function with respect to the stimulation of T cells as the non-modified protein fragment/peptide.

12. The process for the preparation of a protein fragment/peptide according to claim 10 or 11, wherein said protein fragment/peptide contains at least one additional naturally occurring or not naturally occurring amino acid and/or a protecting group at the N-terminal and/or C-terminal end (extended modification), wherein the extendedly modified protein fragment/peptide has essentially the same function with respect to the stimulation of T cells as the non-modified protein fragment/ peptide.

13. Use of a protein fragment/peptide prepared by the process according to any of the preceding claims 10 to 12 for the preparation of a medicament for immune stimulation.

14. The use of a protein fragment/peptide according to claim 13, wherein said immune stimulation is a vaccination or desensitization.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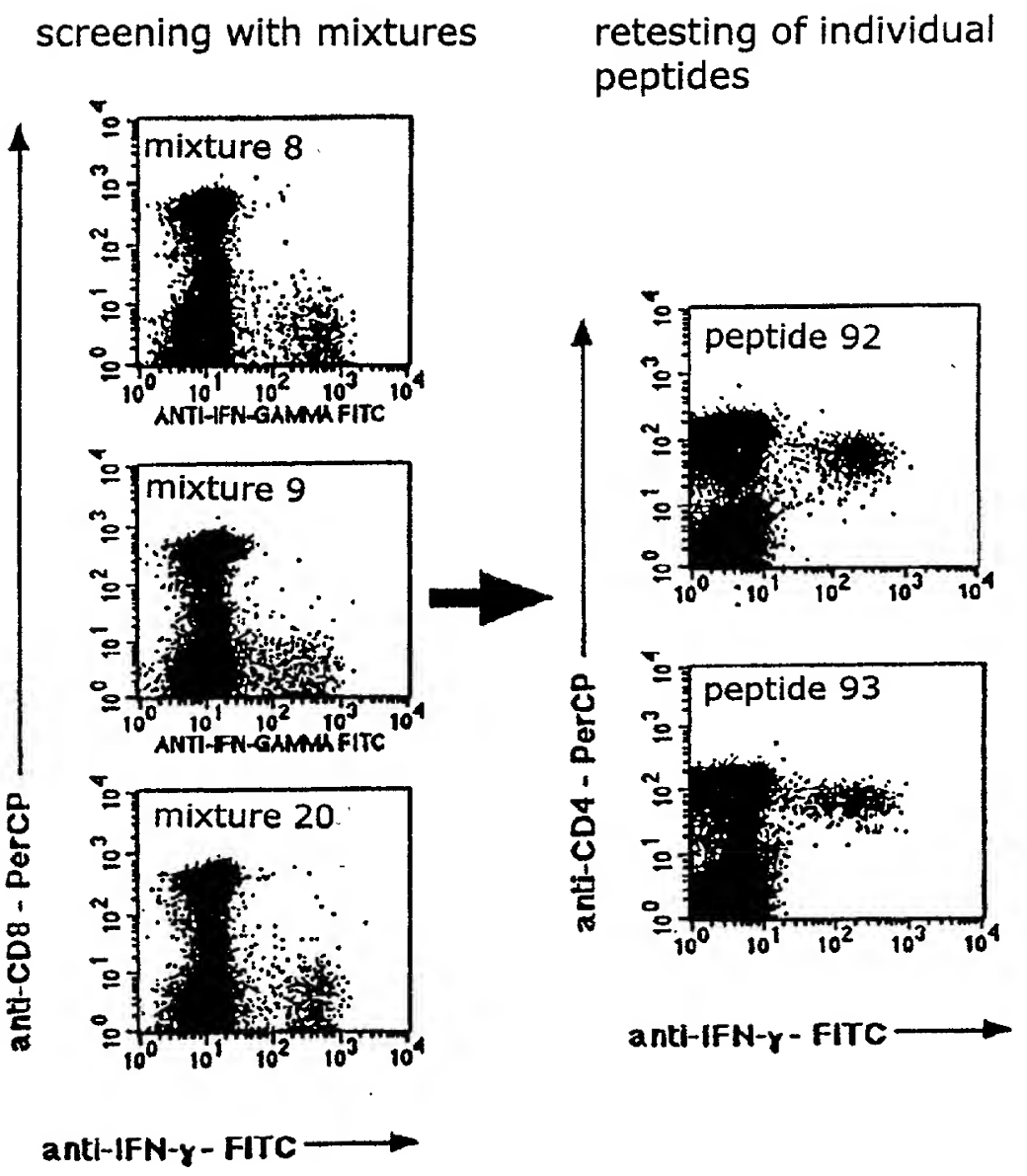
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CLAIMS:

(substitute sheets)

1. A method for the identification of T-cell stimulating protein fragments comprising the following steps:

a) establishing the amino acid sequence of an antigen which is a protein or a peptide;

b) subdividing the detected amino acid sequence of said antigen into protein fragments;

c) synthesizing at least one protein fragment having a length of from 8 to 30 amino acids, or cleaving the amino acid sequence of said antigen into at least one protein fragment having a length of from 8 to 30 amino acids, wherein said protein fragment is a subsequence of the established amino acid sequence of said antigen;

d) incubating a suspension containing T cells with the protein fragment or fragments in different experimental runs;

e) identifying of

(i) at least one T cell cytokin which has been induced by the protein fragment or fragments and synthesized in the T cells, wherein the T cell cytokin or cytokins remain within the cell or are bound to the cell membrane; and/or

(ii) at least one activation marker expressed or expression-enhanced due to the T cell stimulation by the protein fragment or fragments which has been induced or

expression-enhanced by the protein fragment or fragments and which is expressed in the T cells, wherein said activation marker can be present within the cell or expressed on the cellular surface;

wherein said T cell cytokin or cytokins or activation markers are identified by flow cytometry; and

f) assigning the experimental runs in which T cells have been stimulated and such stimulation has been recognized by the identification of one or more T cell cytokins and/or one or more activation markers, to the amino acid sequence or sequences of said protein fragments which had been incubated with the T cells;

characterized in that the incubation time is sufficiently long so that the protein fragment or fragments are sufficiently taken up by the MHC molecules present on the cellular surface, said taking up being sufficient when an unambiguous identification of stimulated T cells is possible; and

the incubation time of the suspension containing T cells with the protein fragment or fragments is sufficiently short so that selection and proliferation accompanied by the specific elimination of particular T cells do not occur.

2. The method for the identification of T-cell stimulating protein fragments according to claim 1, wherein said identification of at least one T cell cytokin or activation marker is made on the individual cell level.

3. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein said suspensions containing T cells contain cells which present the protein fragment essentially in a state bound to MHC class I or class II molecules.

4. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein the protein fragment in the class I restricted presentation comprises from 9 to 11 amino acids, and the protein fragment in the class II restricted presentation comprises at least 11 amino acids.

5. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein said suspension containing T cells is a suspension of whole blood, peripheral white blood cells (PWBC), splenocytes, thymocytes, bone marrow, cerebrospinal fluid and/or lymph node cells.

6. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein said suspension containing T cells is derived from the patients to be subjected to therapy, from donors or from animals.

7. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein the antigens, i.e., proteins or peptides, are derived from polycellular eukaryotes, cells, cell cultures and/or tissues of donors or patients.

8. The method for the identification of T-cell stimulating protein fragments according to any of the preceding claims, wherein the T cell cytokins are of the types interferon-γ, TNF-α or interleukin 2.

9. A process for the preparation of a protein fragment/peptide which is T-cell stimulating and whose amino acid sequence or initial amino acid sequence was found by the method for the identification of T-cell stimulating protein fragments according to any of the preceding claims 1 to 8, wherein said protein fragment/peptide is prepared by the solid phase method, liquid phase method or by protein biosynthesis in a host.

10. The process for the preparation of a protein fragment/peptide according to claim 9, wherein said protein fragment/peptide contains insertions, deletions or substitutions (modifications) wherein one, two, three or more amino acids have been exchanged, deleted or inserted, wherein said modified protein fragment/peptide has essentially the same function with respect to the stimulation of T cells as the non-modified protein fragment/peptide.

11. The process for the preparation of a protein fragment/peptide according to claim 9 or 10, wherein said protein fragment/peptide contains at least one additional naturally occurring or not naturally occurring amino acid and/or a protecting group at the N-terminal and/or C-terminal end (extended modification), wherein the extendedly modified protein fragment/peptide has essentially the same function with respect to the stimulation of T cells as the non-modified protein fragment/ peptide.

12. Use of a protein fragment/peptide prepared by the process according to any of the preceding claims 9 to 11 for the preparation of a medicament for immune stimulation.

13. The use of a protein fragment/peptide according to claim 12, wherein said immune stimulation is a vaccination or desensitization.

SEQUENCE LISTING

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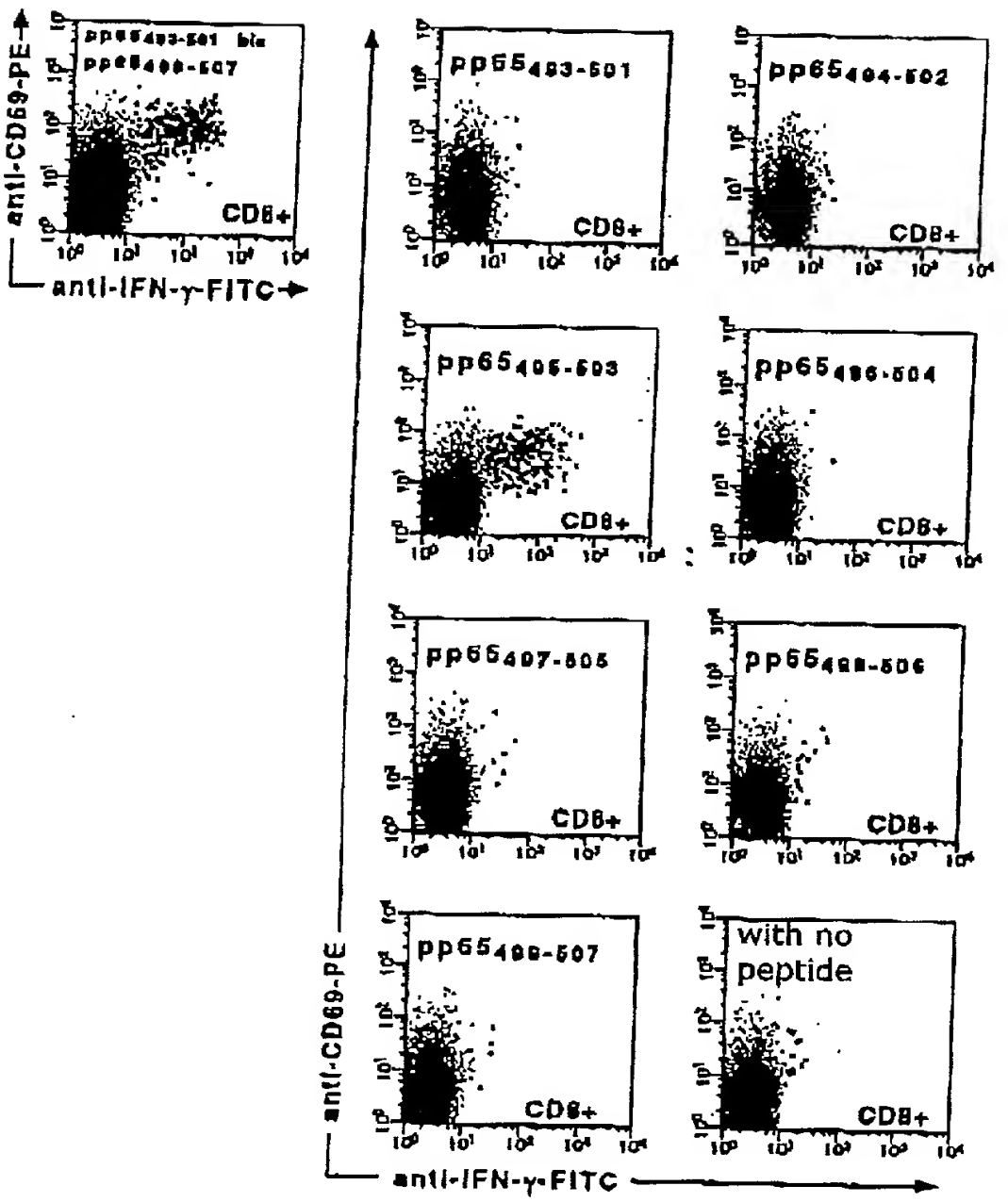
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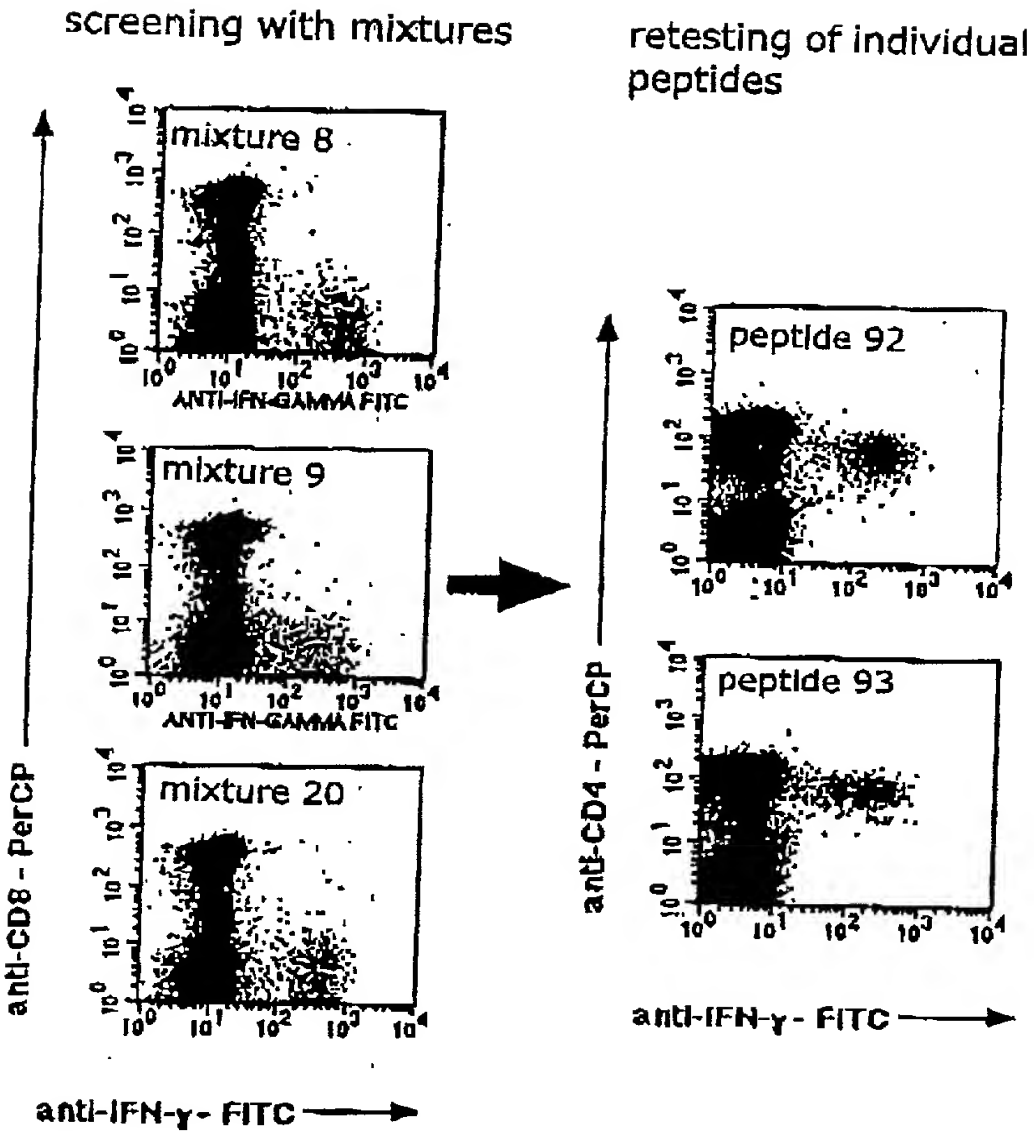
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anti-IFN-γ - FITC

ATTORNEY DOCKET No.: Kreisler 1089-KGB

COMBINATION DECLARATION & POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **METHOD FOR IDENTIFYING T-CELL STIMULATING PROTEIN FRAGMENTS**

the specification of which is attached hereto.

was filed on July 19, 2000 as application Serial No. 09/600,564.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
198 02 174.7 (Number)	DE (Country)	19. January 1998 (Day/Month/Yr. Filed)	[x] yes [ ]no
198 34 932.7 (Number)	DE (Country)	28. Juli 1998 (Day/Month/Yr. Filed)	[x] yes [ ]no

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States Provisional Application(s) listed below.

(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code

of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punished by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

Kurt G. Briscoe, Reg. No. 33,141; William C. Gerstenzang, Reg. No. 27,552; Stephen G. Ryan, Reg. No. 39,015 and Lorimer P. Brooks, Reg. No. 15,155; all of 660 White Plains Road, Tarrytown, New York 10591-5144; William R. Robinson, Reg. No. 27,224; Davey E. Zoneraich, Reg. No. 37,267 and Mark A. Montana, Reg. No. 44,948 all of 721 Route 202-206, Bridgewater, New Jersey 08807, my attorneys with full power of substitution and revocation.

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6 of

FULL NAME OF SIXTH INVENTOR: _____

INVENTOR'S SIGNATURE: _____ DATE: _____

RESIDENCE: _____ CITIZENSHIP: _____

POST OFFICE ADDRESS: _____